INDIAN TEA ASSOCIATION.

SCIENTIFIC DEPARTMENT

TOCKLAI EXPERIMENTAL STATION

ANNUAL REPORT 1950.

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1. CHIEF SCIENTIFIC OFFICER'S REPORT.

(1). Staff and Administration.

During the year two additional Officers were appointed to the Staff in the capacity of Executive Officer and Advisory Officer, Dooars respectively. Thus the Senior Staff is now made up as follows :—

				Year of joining
C. J. Harrison	...	Chief Scientific Officer	...	1924
W. Wight	...	Botanist	...	1930
E. A. H. Roberts	...	Chief Biochemist	...	1937
N. G. Gokhale	...	Soil Chemist	...	1946
E. Hainsworth	...	Plant Pathologist	...	1947
S. K. Dutta	...	Agriculturist	...	1948
D. J. Wood	...	Second Biochemist	...	1948
G. M. Das	...	Entomologist	...	1948
R. I. Macalpine	...	Advisory Officer, Darjeeling	...	1948
P. M. Glover	...	Advisory Officer, Assam	...	1948
J. W. Crichton	...	Advisory Officer (Designate) Dooars	...	1950
J. Watson-Morton	...	Executive Officer	...	1950

Of the above Officers Mr. E. Hainsworth was on leave from 9th December 1949 to 21st July 1950, and Mr. N. G. Gokhale was on leave from 4th December 1949 to 4th October 1950. In both cases these Officers availed themselves of study leave facilities.

The Annual Conference was held at Tocklai from the 6th to the 8th December 1950 and was attended by delegates from Calcutta and all the tea districts in North East India. The Proceedings of this Conference have already been printed and circulated to Indian Tea Association Members.

Three general lecture courses were held during the year, as were also two vegetative propagation courses.

A total of 3,97,567 lbs. of green leaf was plucked from approximately 80 acres of experimental tea at Borbhetta (as compared with 3,79,700 lbs. in 1949). The crop sold in 1950 (as green leaf) was 4,619 mds. for the sum of Rs. 55,428/-. In addition to this 8,009 rooted cuttings of 3 clones were sold. The sum of Rs. 72,080 was realised from this sale.

The income from the sale of publications amounted to Rs. 22,673/-

ADVISORY BRANCH : ASSAM VALLEY AND NORTH BANK.

1. Touring.

In the Assam Valley tours were carried out in the Jorhat, Nazira, Sonari, Golaghat, Moran, Tingri, Nowgong, Doom Dooma, Naharkatiya and Panitola Circles, involving visits to more than 50 Gardens.

Two tours were made of the North Bank to the Bishnath and Borsola Circles and visits were paid to 21 gardens

Two short visits were made to Cachar and 10 gardens were visited.

The Advisory Officer was unwell during part of April and May and was unable to tour and this rather restricted the number of gardens he was able to visit during the year. A number of visits to Calcutta were made in connection with the Cachar Plantation Enquiry committee.

2. Tea Encyclopaedia.

Serials 73 and 81 on the Fertiliser position for 1950 and 1951 respectively were published in conjunction with the Chief Scientific Officer and the Soil Chemist. Serials 70,77 and 78 were written in co-operation with the Pathologist and Entomologist on Root Diseases of Tea, Termite Control and Cricket Control. Serial 82 on Bamboos was written in conjunction with the Chief Scientific Officer and the Advisory Officer, Darjeeling and Terai Serial 33 "Recipes for Sprays which can be prepared home made on the garden" was rewritten, brought up to date and republished.

3. Memoranda.

Over 500 memoranda were issued during the year in answer to letters or as result of visits to gardens.

4. Publications.

A report on the "Condition of the Tea Industry in Cachar with Recommendations as to Improvement" has been prepared and is now in the Press. This report is that submitted by the Advisory Officer to the Cachar Plantation Enquiry Committee (separately reported) as representative of the Scientific Department on that Committee. It is being published with their kind permission.

5. Lectures.

Lectures were given on Hedge Planting on the Sixth and Seventh Vegetative Propagation Courses.

The Advisory Officer took charge of Pest and Disease Control lectures and demonstrations on the three Lecture Courses held in February-March 1950 and also lectured on Advisory Work. He also lectured on Soil Management on the last Course in the absence of the Chief Scientific Officer.

A short talk on Pest and disease control was given at Dibru-Darrang.

Lectures on manufacture were given in Mazbat, Misa, East Boroi and Bishnath clubs.

A brief talk on the fertiliser position for 1951 was given at an informal meeting of the Indian Tea Association held in Calcutta on 6th October 1950.

6. Meetings.

The Advisory Officer attended the Surma Valley branch I. T. A. Annual General Meeting held in Silchar in January 1950, representing the Chief Scientific Officer and addressed the meeting.

He also attended the Assam Valley Branch I. T. A. Annual General Meeting held in the Panitora Club in November 1950.

7. Cachar Plantation Enquiry Committee.

The Advisory Officer was appointed to the Cachar Plantation Enquiry Committee by the Government of India, representing the Scientific Department.

Meetings of this Committee were held on 3rd to 5th October and again on 20th and 21st. December in Calcutta. The Committee toured Cachar between 30th November and 2nd December, and held discussions with both Managers and Labour. Visits were paid to the following Cachar gardens. Silcoorie, Boro Jalinga, Bundookmara, Urunnaband and Koomber.

Further meetings will be held on 3rd and 4th January 1951, to finalise the Committee's report.

The Advisory Officer prepared a detailed technical report on the condition of the tea industry in Cachar with recommendations as to improvements, which should be made. This technical report has been accepted "*in toto*" by the Committee and will appear as Chapter II of the Committee's report.

Permission was requested to publish this technical report as an I. T. A. bulletin, this was granted by the Cachar Plantation Enquiry Committee and its publication has been approved by the Chairman, Indian Tea Association. This report is now in the Press, and will be issued shortly.

8. Red Rust.

An experiment has been laid out at Kotalgoorie Tea Estate at the special request of the Manager to investigate the possibility of eradication of Red Rust from young tea, which is severely affected, by adjustment of pruning dates and modification of pruning methods.

It has been laid out as a random block experiment. Each plot being 8×8 bushes—64 bushes planted $4\frac{1}{2}' \times 4\frac{1}{2}'$ triangular.

1. Pruned June 1950, normal cut across and clean out prune :
2. Pruned June 1950, similar to treatment 1, but removing *all* green shoots irrespective of where they arise on the bush, including all those on the side branches.

3. Pruned October 1950, normal cut across prune :

4. Pruned October 1950, similar to treatment 1, but removing *all* green shoots irrespective of where they arise on the bush, including all those on the side branches.

All pruning heights 20". from the ground.

Two rows of tea left as guard lines surrounding each plot. Bushes in guard lines pruned in June 1950 ; and all green shoots removed including those on the side branches. Bushes in guard lines to be sprayed with Perenox 1 lb. to 40 gallons, twice in 1951.

A thorough examination will be made for Red Rust in April-May 1951.

9. Manuring on Bheel Soils.

An experiment has been laid out at Bhubandhar T. E. in Cachar to investigate the possibility of increasing yield per acre from Bheel soils on which previous experience has shown nitrogen to have no effect.

The design is a 3×3 randomised block. Preliminary yields have been obtained during 1950.

Treatments will be :

P_2O_5 60 lbs. and K_2O 90 lbs. per acre.
Cattle manure at 200 mds per acre.
Calcium sulphate (Gypsum) at 1 oz per bush.

A second experiment is being designed in conjunction with the Scientific Officer of the Jokai Tea Company and preliminary yields will be taken in the coming year.

10. N. P. K. Experiments.

A series of experiments was started in 1937 to detect any detrimental effect which might arise over a period of years from the application of an unbalanced fertiliser (i. e. supplying nitrogen only) to tea.

These experiments were begun in 1936-37 ; all manuring was stopped in 1944 to 1947 due to war time shortages. In 1948, as no superphosphate was available, only N and K were applied. In 1949 full manuring was begun again for the first time since 1943, at the following rates :

N 120 - P 40 - K 40.

Results obtained during 1950 are given below :

(a) On Bindukuri T. E.

Experiments X70 and X71. All treatments gave yields significantly above the check. The mean effect of nitrogen was + 4.8 mds. and + 3.7 mds. respectively, significant at the 5% level.

Under these conditions in Experiment X70 yields from NP and NK and NPK were no better than from N alone. In Experiment X71 yields from NP and NK were 1.6 and 2.7 mds. less than from N alone, the yield from NPK no better. These differences are not significant at the 5% level.

(b) On Moortee T. E.

Nitrogen alone again gave no increase in yield. Increases were obtained only from fertilisers containing phosphates, i. e., NP and NPK, these amounted to approximately 1 maund per acre, and are not signifficant at the 5% level.

(c) On Rydak T. E.

Nitrogen alone gave an increase in yield of +3.8 mds. per acre over the check No significant increase was obtained from NP NK or NPK. The figure for nitrogen is significant at the 5% level.

11. Organic and Inorganic Manures.

This experiment was begun in 1933, and was designed to test the relative values of bulk organic (i. e.) cattle manure, and balanced inorganic fertilisers for tea..

The tea is Manipuri planted 8' × 4' triangular planted 1922-23, possibly from the Doliaguri bari The soil is very sandy in the Northern plots, sandy in the Southern. The shade is mixed Sau and Koroi, Koroi was the original shade, the Sau are replacements. The shade is heavy approximately 40' × 20', the light intensity under the trees averaged only 40% of the light in the open in August.

Treatments are :

Organic fertiliser—

Cattle manure at 200 mds. per acre.

Inorganic fertiliser —

N 40 lbs. per acre as SCA
P 20 lbs. per acre as Superphosphate
K 20 lbs. per acre as Sulphate of Potash.

In the early years, 1933 to 1936 inclusive, yields from plots manured with inorganic fertiliser were greater than from those manured with cattle manure, though not significantly so at the 5% level. Then from 1937-1944 inorganic manures gave yields significantly greater than cattle manure. From 1245 to 1949 yields from cattle manure increased. Yields from inorganic fertilisers were not significantly greater than from bulk organics, at the 5% level, with the exception of 1946. In 1950 the yield from inorganic fertiliser was 1.4 mds. greater than from cattle manure ; this difference is significant at the 5% level.

The cost of inorganics in 1950 worked out to roughly Rs. 68/4 per acre of which about Rs. 1/11 was cost of application. Cost of cattle manure worked out to Rs. 24/6 per acre of which Rs 12/11 was application cost.

12. Shade— Nitrogen and Plucking.

Experiments are in progress on one garden in the Jorhat Circle and three in the Dooars. Treatments are :

Two levels of nitrogen, 40 lbs. and 120 lbs. per acre.
Two tipping heights 6" and 9".
Shade and No Shade.

(a) On Hunwal T. E.

In the Jorhat Circle the experiment is now in its fourth year. The shade is very light and the tea Assam indigenous (Betjan) P and K at 40 lbs. are applied at both levels of nitrogen. Under these conditions again a considerable increase in yield (+6·6 mds.) has been obtained from the application of 120 lbs. nitrogen per acre as compared with an application rate of only 40 lbs. per acre. It is of course possible that an equally good response might have been obtained from a lower level of nitrogen.

This increase in the fourth year of the experiment is not significantly greater from unshaded than from the shaded plots. The gain from shade is considerable, but again is not significantly greater from the plots with lower rate of nitrogen than from those with the higher rate, at the 5% level. As before, in the fourth year of the experiment, there has been no loss in crop as result of the more generous tipping measure. Raising the tipping horizon has had no effect on yield with either level of nitrogen with or without shade. The only significant loss to occur as result of raising the tipping horizon, was in the first year, thereafter, there has been no significant gain or loss in crop. It will be interesting to watch in future years whether the benefit from additional growth starts to show up in increased yields.

(b) At Moortee T. E.

The higher level of nitrogen gave an increase in yield of 0. 9. mds. with unshaded tea. There was no gain from the shaded area. With the lower rate of nitrogen the gain from shade was 1. 2 mds, at the higher rate there was no gain. These figures are not significant at the 5% level. The longer tipping measnre gave an average increase in yield of 2. 1 mds, the gain with the lower level of nitrogen was 1. 5 mds, and with the higher level 2 7 mds. The gain in crop from lighter plucking was negligible on the shaded area and amounted to +3. 5 mds. on the unshaded plots. Figures are significant at 5% level.

(c) At Baradighi T. E.

The higher level of nitrogen gave an increased yield of 1. 1 mds. with unshaded tea ; and no return from the shaded ares. There was an overall loss from shade of 3. 3 mds, being 2. 5 mds. with the lower rate of nitrogen and 4. 1 mds, with the higher. Figures are significant at the 5% level. The longer tipping measure resultcd in no gain or loss in crop at the lower level of nitrogen ; with the higher level there was a loss of 0. 9 mds, it resulted in a loss of 0. 9 mds, on the unshaded plots, on shaded plots it had no effect. These figures miss significance at the 5% level.

(d) At Rydak T. E.

The higher level of nitrogen gave an increase in yield, of 1.7 mds. from the unshaded plots and no gain from those shaded. Shade was beneficial to the extent of 1.1 mds at the lower rate of nitrogen but had no such effect at the higher level. The increased tipping height had no significant effect on yield with or without shade. It reduced yield by 1.4 mds. (significant at the 5% level) at the lower level of nitrogen and had no significant effect at the higher level.

13. Sulphate of ammonia and Oilcake.

Experiment X98 at Jamirah T. E. is now in its third year. The tea is Bokel Manipuri planted 1913-14. The shade is heavy. The soil is very sandy.

Treatments are :

Check
80 lbs. N per acre as oilcake
80 lbs. N per acre as sulphate of ammonia.

In the first year yields from both treated plots were greater than from the check ; but these differences were not significant. In the second year the increase in yield from 80 lbs. N as sulphate of ammonia was just over 6 mds. per acre as compared with an increase of only $2\frac{1}{2}$ mds. from plots receiving oilcake, In 1950, the increase in yield from **both** treatments amounted to $5\frac{1}{4}$ mds. per acre. These figures are significant at the 5 % level.

This experiment will be continued for a number of years, in order to see whether this high yield from oilcake applied to Manipuri tea on a sandy soil under heavy shade, will he maintained.

14. Shade and Manuring.

These experiments have been running now for only three years, and it is too early yet to attempt to come to any conclusions.

In general, tea whether Assam indigenous or Manipur, gives a greater response to the higher level of nitrogen than the lower as sulphate of ammonia, where the shade is light or medium.

Where the shade is heavy or very heavy, with few exceptions, neither Assam indigenous nor Manipuri kinds give any increase in crop with an increase in nitrogen application from 60 lbs. per acre to 120 lbs. per acre.

The response to organic manures in the form of oilcake at 200 lbs. N per acre, follow the same general trend, the increase in yield obtained being roughly of the same order as that from only 120 lbs. N as sulphate of ammonia.

(P.M. Glover)
Advisory Officer,
Assam Valley and North Bank.

BIOCHEMICAL BRANCH

Touring And Advisory Work.

There has been a considerable increase in the amount of advisory work called for on Tea Manufacture. In all 142 memoranda were issued in 1950 against 96 in 1949 and 40 in 1948. In addition to this a considerable number of reports were issued by Mr. Gilchrist, who was tasting for us throughout the latter half of the season.

Many of the memoranda were routine reports of factory visits arising from tours, but many queries were received. Typical subjects of queries are listed below :—

The lay out of new factories.
The ratio of made tea to green leaf
Single bush manufacture.
Improved methods of green leaf sifting.
The use of aluminium for fermenting surfaces.
The pros and cons of single and double firing.
The Carter stalk extractor.
The picking up of moisture by tea on storage.

Touring has largely been concentrated on the Darjeeling district where factory experiments were being carried out on the effects of higher withers on the amount of rolling required to bring about adequate fermentation.

Dr. Roberts was on tour in the Darjeeling district from April 24th. to May 1st. after which a brief visit was paid to the Duars and the Terai. Mr. Wood later toured in Darjeeling from June 5th. to 14th. and Dr. Roberts was again in Derjeeling from September 26th. to October 15th. Dr. Roberts was also on tour in the Panitola district from June 27th. to July 1st. In addition several local factories were visited, mainly in connection with the carrying out of factory experiments. Although the primary object of most of this touring was the carrying out of experiments the opportunity was taken in all factories visited of collecting information for the systematisation of manufacturing procedures. Purely advisory visits were alse carried out

FACTORY EXPERIMENTS.

I. WITHERING.

Withering and its effect on liquor characters.

The effects of variation in the percentage wither on the liquor characters of made tea have been investigated. This was a laboratory scale experiment in which the Pizey roller was employed for rolling. A high wither was obtained by keeping the leaf close to a fan, and a low wither by placing the leaf under a bell jar where the air was maintained at a 100% R. H Intermediate degrees of wither were obtained by adjusting the thickness of spread under conditions of natural withering.

The withered leaf was rolled for 1 hour, fermented for an inclusive period of 3 hours and all samples were fired simultaneously on the top tray of a Venetian dryer.

Our Taster's reports on these teas showed conclusively that colour and strength fell off progressively with an increased hardness of wither whilst quality and briskness improved. This shows that so long as the rolling treatment remains the same, liquor characters are considerably affected by the degree of wither. It was also shown that with high withers improved strength and colour could be obtained as a result of further rolling. In this connection it may be noted that in the Assam Valley, where withers tend to be light, two 30-minute rolls are normally sufficient for a full fermentation, whereas in Ceylon and S. India, where a high wither is the rule, three or more rolls are customary.

The results of these experiments suggest that colour and strength will be well developed in teas manufactured on a no-wither system. The briskness of such teas can be improved by a reduction in fermenting time, at the expense of some strength and colour.

The valuations given by our taster indicated that the higher briskness and quality of the more highly withered teas more than compensated for the loss of colour and strength, so that a well withered tea was valued more highly than one where the wither was very light. How far this conclusion applies to normal factory procedure cannot yet be stated.

Manufacture from unwithered leaf.

Comparisons were made between teas manufactured from fresh unwithered leaf, from leaf kept 18 hours in an atmosphere of 100% R. H. (this was practically unwithered), and from normally withered leaf. Teas manufactured on a laboratory scale were submitted to representative tasters for their opinion.

All tasters agreed that the withered leaf produced the best tea both in appearance and liquor characters. The tea manufactured from fresh leaf was characterised as brassy, metallic, harsh, raw and unfinished. The result of keeping the leaf for 18 hours without appreciable withering, is a loss of this metallic character together with a thicker liquor and slightly duller colour. Both teas made from unwithered leaf had, of course, a flaky, shelly leaf, while the tea made from withered leaf had good appearance.

These experiments indicate very strongly that the omission of the wither results in an unpleasant character, referred to generally as brassy or metallic. This character appears to be lost if the leaf is kept for 18 hours without withering, although the resultant tea is still not so favourably viewed as one made from normally withered leaf. It is probable that the metallic character of unwithered tea could largely be eliminated by spreading the freshly plucked leaf in heaps several inches deep and manufacturing the following day, (this is actually done in some factories). The bacterial infection likely to develop in most cases as a result of this treatment would however probably outweigh the advantage gained by elimination of the metallic character.

Effects of withering and rolling on green teas.

A green tea can be made by firing freshly plucked leaf. An infusion of such dried leaf was found to be "flat" and tasted of cabbage water. These unpleasant characters were not observed if the leaf was withered before drying. It appears again as if the withering has resulted in chemical changes reflected in improved quality of the tea.

Green teas however are customarily manufactured from unwithered leaf, but the leaf is first steamed and then rolled before being fired. Immersion of fresh leaf in boiling water for a few seconds does not destroy the cabbage water character, as an infusion of leaf so treated before drying still shows this character ; but if the leaf after this treatment is rolled, a green tea is produced without any of the unpleasant characters associated with the dried green leaf. It therefore appears that if leaf can be given the twist characteristic of a good roll the quality of its liquor is improved. Both withering and a successful roll therefore probably contribute to the superior liquoring characters of a normally manufactured tea as compared with those of a non-wither tea, for in the latter case no twist can be imparted during manufacture.

II. ROLLING.

The function of the second roll in manufacture.

The results of factory experiments, briefly reported in the Annual Report for 1949, have shown that a second roll has comparatively little effect on the chemical composition of the coarse leaf left after removal, by green leaf sifting, of the first fine mal. Comparison of this leaf with unsifted leaf after the second roll shows little essential difference in chemical composition, indicating that the second roll has had little effect either on the rate or extent of fermentation. Tasters' reports, on the other hand, showed a considerable increase in depth of colour and strength as a result of the second roll. This apparent contradiction was resolved, and it was shown that the second roll although not bringing about further fermentation resulted in more rapaid extraction of the water-soluble matter, so that a stronger, more coloury liquor was obtained in the taster's 5-minute infusion.

As the second roll only results in an increased extraction of water-soluble matter in the taster's infusion, the chemical composition and liquoring properties of teas should be approximately the same no matter at what stage the second roll is given. In 1949 and 1950 ten comparisons have been made of teas obtained with the second roll immediately after the first roll, and just before firing. No appreciable difference, on the average, is found between these treatments as far as the taster's opinions are concerned. Chemically there is a tendency, not amounting to statistical significance, for the teas with the delayed second roll to be slightly less fermented. This suggests that the second roll has resulted in a slight increase in the extent of fermentation but that the effect is small. If this slight increase is confirmed, as a result of further experiments, it will not affect the conclusion that the main result of the second roll is to increase extraction of water-soluble matter in a 5-minute infusion.

The effect of C. T. C. treatment on rolled leaf.

It has been established that C. T. C. treatment of the coarse leaf, remaining after the first or second green leaf sift, results in a considerable enhancement of strength and depth of colour. The effects of C. T. C. treatment are greater than those of a second roll. Our results show that not only is the extraction of water-soluble matter increased by C. T. C. treatment but that the rate of fermentation is also accelerated, hence the lower fermentation times necessary with such leaf. A comparable increase in the rate of fermentation is not observed with a second roll. This effect is probably bound up with the extensive breaking up of the leaf which occurs in the C. T. C, oxygen having a shorter distance to diffuse to the active centres (chloroplasts) within the leaf where the greater part of the fermentation takes place.

The effects of higher withers on the number of rolls necessary for full fermentation.

As shown in our withering experiments the effects of a high wither include a greater resistance to mechanical damage in the rolling process. It has been established experimentally that no better strength or depth of colour results from an increase in the number of rolls from two to three (each of 30 minutes duration) with the relatively light withers customary in the Assam Valley. This conclusion does not necessarily apply in cases where the wither is higher.

Experiments were therefore carried out in the Darjeeling district where the normal wither is generally higher than in the Plains of N. E. India, although not so high as in Ceylon and S. India. Thirteen comparisons were made of teas manufactured from the coarse leaf after the first green leaf sift and from unsifted leaf after the second roll. These results gave us the effects of a second roll. Seventeen comparisons were also made of teas manufactured from the coarse leaf after the second leaf sift and from unsifted leaf after a third roll, giving the effects of the third roll.

The chemical analyses left no doubt that in these experiments complete fermentation could not be achieved after one roll, in contrast to the findings in our Assam Vally experiments. The third roll also resulted in a slight increase in tho extent of fermentation, but this was not statistically significant. A small but appreciable increase in strength and depth of colour also resulted from a third roll, and it is concluded from the results so far obtained, that although good teas can be manufactured under Darjeeling conditions with two rolls only, a third roll may at times be advantageous. There is little doubt that with hard withers, where 100 lbs. of leaf is withered to 55 lbs. or less, three rolls would be necessary.

III. SPRAYING EXPERIMENTS.

It has been demonstrated, in collaboration with the Plant Pathology Department, that spraying, immediately after plucking, has no deleterious effects on quality in the cases where Lime Sulpher, DDT and Perenox are employed. Gammexane however taints the tea badly. On plucking one week after

spraying, all the teas manufactured from Gammexane treated bushes were reported upon as unsaleable. After a second plucking round, one week later, half of the bushes manufactured were still so badly contaminated that the Taster could not value them. After three weeks the effect had largely passed off although a slight taint could still be detected on most of the bushes.

It is hoped to make a further trial of an odourless variety of Gammexane in 1951.

IV. EXPERIMENTS WITH A HYDRAULIC PRESS.

Further experiments have been carried out with a hydraulic press. It has been found that the expression of juice from partly rolled leaf, whether unwithered or lightly withered, results in very appreciable losses in the constituents of the leaf responsible for liquoring characters. A saving in the load on firing machines by hydraulic expression of juice is therefore a doubtful economy, and one which cannot be recommended.

FUNDAMENTAL RESEARCH WORK.

I. PUBLICATIONS.

The results of the last three years fundamental research work have been written up in a form suitable for publication in various scientific journals. Full details of the work carried out can be found in these papers.

II. THE MECHANISH OF TEA-FERMENTATION.

A consequence of the localisation of the tea oxidase in the chloroplast (Annual Report 1948) is that although water-soluble, it is extremely difficult to extract either from green leaf or from preparations. The recognition that the oxidase is only apparently insoluble in water has enabled us to reconcile many previous apparent inconsistencies in the recorded properties of this enzyme.

It has now been concluded that the respiratory activity in withered tea leaf is almost completely destroyed on rolling and that with ths light withers in the Assam Valley, one 30 minute roll is sufficient for this purpose. The chemical changes taking place in such rolled leaf are confined almost entirely to the oxidation of the catechins. The carbon dioxide evolved is mainly a result of such oxidations and is not of respiratory origin to any great extent, while secondary oxidations of such substances as amino-acids and fats are considered improbable.

III. THE CHEMICAL COMPOSITION OF TEA-LEAF.

Polyphenols.

The work of Bradfield on the identification of the catechins in tea has been further extended and our present views are that the following catechins occur naturally in tea.

1. *l*-*Epi*gallocatechin.
2. *d*-Gallocatechin.
3. *l*-*Epi*catechin.

4. *d*-Catechin.
5. *l-Epi*galloeatechin gallate.
6. *l-Epi*catechin gallate.

Traces of *d*-gallocatechin gallate and *d*-catechin gallate are occasionally found and one clone (14/3/32) contains appreciable quantities of *d*-gallocatechin gallate.

The reasons for the above provisional identifications are the subject of a paper now in preparation for publication in the Biochemical Journal.

In addition to these catechins the polyphenols of tea-leaf include what is believed to be *m*-digallic acid and small amounts of gallic acid. There are trace amounts of at least seventeen other polyphenols in addition to a large number of substances, rather loosely referred to as anthoxanthins, which give a yellow colour reaction with ammonia. It has been shown that two of these latter substances are probably to be identified with rutin and chlorogenic acid. It has been shown that most of these substances can be broken down into simpler substances on hydrolysis with hydrochloric acid and it is probable that most of them are either glycosides of the flavonols, such as rutin, or depsides such as chlorogenic acid.

None of the unidentified polyphenols or anthoxanthins occur in sufficient quantities in the leaf for them to be likely to be of significance in determining liquor characters, as is also indicated by the absence of appreciable effect on the palate when rutin is added to an infusion. These minor components however vary considerably in different botanical types of tea and such variations in chemical composition may prove of genetical significance.

Differences in the relative proportions of the indentified polyphenols in teas of different types are slight and are insufficient to explain the marked variations of quality observed in the manufactured teas.

It is quite clear from this survey of polyphenols in tea that if there are any true tannins in the tea leaf they are present in very low concentrations.

It has been observed that during fermentation there is a very considerable increase in the amount of free gallic acid present. Green leaf contains little and sometimes no detectable amount of gallic acid, and this increase on fermentation is almost certainly the result of the breakdown of gallic acid esters. We have been unable to establish that this breakdown is associated with esterase activity and it is possible that liberation of free gallic acid follows oxidation of these esters in fermentation.

The distribution of the polyphenols in various parts of the shoot has been studied. As one descends the shoot from the bud and first leaf to the maturer second and third leaf it is obesrved that the simple catechins increase in strength whilst the gallic acid esters and *m*-digallic acid decrease. In old leaf the simple catechins predominate. In the stem *m*-digallic is much less abundant than in the leaf. These differences must account at least in part

for the very different liquor characters of teas made from different portions of the shoot. The entirely different characters of teas manufactured from stem, first, second and third leaf may be instanced in this case..

Amino-acids.

Practically all the naturally occurring amino-acids and their amides have been detected in tea-leaf together with *B*-alanine and *Y*-aminobutyric acid which latter are frequent constituents of vegetable tissue. There is also a number of unidentified substances (referred to in the table below by designations such as 10 G) which resemble amino-acids. Most of these occur in traces only, but the substance referred to as 10G is the most abundant of the nitrogen-containing substances in the tea-leaf, next to caffeine, This substance is known to yield glutamic acid on hydrolysis and is also probably an amide. As an important component of tea it requires much further study.

The table below records the amino-acids etc. so far detected in tea and also shows the effect of withering on their approximate concentration in the leaf. (This concentration is represented by figures ranging from 0 to 10 where 1 indicates an amount just detectable and 10 represents a relatively considerable quantity). It will be seen that the amino-acids and amides such as asparagine and glutamine increase as a result of withering. This is a consequence of the breakdown of protein during withering.

This clearly establishes a marked chemical change in the course of withering and other similar changes in the carbohydrates and pectins are also likely. It is therefore incorrect to consider the wither as a purely physical process and it is to be expected that the chemical changes taking place during withering will be reflected in changes in the liquoring characters of the teas.

Amino-acid.	Relative concentration of amino-acid.	
	Fresh Leaf.	Withered Leaf.
1A	1	nil
Aspartic acid	3	5
3E	1	trace
Glutamic acid	4	5
Hydroxylysine (?)	trace	0-1
Serine	2	3
Asparagine	0-1	3
Lysine	1	2
Threonine	1	2
6A	nil	0-1
Glutamine	2	3
Alanine	2	3
Arginine + Histidine	0-1	0-1
7D	1	1
B-Alanine	0-1	1
Tyrosine	1	2
8F	1	0-1
Proline	nil	1
9E	1-2	1
Y-Aminobutyric acid	1-2	2
Valine	1	4
Tryptophan	0-1	1
Leucines + Phenylalanine	1	4
10G	10	10

The amino-acid distribution in leaf and stem is quite different. In stem glutamine and 10G are in relatively high concentration whereas the amino-acids are in lower concentration than in the leaf. This difference may account in part for observed differences in liquor characters between teas manufactured from leaf and stem.

E. A. Houghton Roberts
D. J. Wood } Biochemists.

R. C. J. H. Gilchrist Tea Taster.

PHYSICO-CHEMICAL LABORATORY

1. General :

The old title of this department, viz Soil Research and Analytical laboratory, will not be used in future. Henceforth this department will be known as the **Physico-Chemical Laboratory,**

The main intersts of this laboratory are

(a) Soil physics
(b) Soil chemistry in its widest aspects
(c) Pedology
(d) Chemistry of fertilisers and manures
(e) Chemistry of fungicides, insecticides and herbicides
(f) Chemistry of water technology
(g) Physics of the air
(h) Relationships between soil/climatic conditions and health/diseases of plants : effect of ecological factors on incidence of pests/diseases.

The building known as Chemical laboratory is being shared by this department with the Biochemical staff and the room at our disposal is quite inadequate for our purposes. This building is now being extended eastwards.

2. Direction.

The Physical Chemist was on combined leave and study leave for most of the year (rejoined on 5. 10. 50.). During his leave he spent about 6 months in the Soil research laboratory of the Department of Agriculture, University of Oxford. Visits were also paid to some of the leading research stations of U. K., N. A. A. S. soil testing laboratories and some of the University centres. He attended the 4th International Congress of Soil Science in Amsterdam in August 1950 and also visited some of the research stations in Holland.

During his absence the department was under the supervision of Dr. Roberts, Biochemist, and Mr. S. N. Sarma, Assistant Chemist.

3. Personnel :

Mr. S. K. Dey, B. Sc. (Hon.), A. I. A. R. I. joined this department as Assistant Chemist from 1. 6. 50.

4. Routine Work :

4. 1. Analytical Work : An unusually large number of soil samples were received during the year, specially during the first quarter. Although this meant that the department had to spend most of its time on purely routine work, we welcome it on the ground that it shows increased awareness on the part of the garden managers to make use of facilities offered by Tocklai.

Soil samples analysed	...	675
Manure „ „	...	167
Water „ „	...	22
Others	...	13

4. 2. Advisory Work : During the year, 1950 advisory reports were issued to gardens in response to queries about specific problems. During the absence on leave of the Physical Chemist this burden fell mainly on Dr. Roberts. The undersigned wishes to take this opportunity of expressing his thanks to Dr. Roberts for doing this extra work.

5. Touring :

After returning from leave in October the Physical Chemist paid visits to three gardens in the Jorhat Circle and also made a tour of the earthquake affected gardens in North Lakhimpur.

6. Climatology :

6. 1. Meteorological Observations : Daily observations at this station are the responsibility of this department. Regular observations are taken every day at 8 a. m., 12 noon and 2 p. m. The instruments installed at this station include Maximum and Minimum thermometers, Dry and Wet bulb thermometers, a Solar Radiation thermometer, Soil thermometers, a Barometer, a Rain gauge, an anemometer and a Sunshine recorder. Recently a seismograph has also been installed (see para 7 below),

Weather conditions during the year have again been rather abnormal. The number of wet days during the year has been high for the third successive year and the rainfall ecorded at Tocklai of 103.93″ is the record for the station. The distribution was peculiar, July being an excessively wet month with 29.28″ of rain. Temperatures have, in general, been lower than usual and the winter was mild as can be seen from the rather high minimum temperatures recorded during November-December. October was Specially cloudy and climatic conditions during the last quarter have been Specially favourable for Blister blight, *Exobasidium vexans*. Full data for 1950 is given below.

STATEMENT A.

1950	Rainfall (Inches)	Wet days	Temp. Maximum monthly average	Temp. Minimum monthly average	Hours sunshine daily average	Rainfall average 33 years	
						Inches	No. of wet days
January	2.14	8	71.35	47.80	5.87	0.91	4.7
February	2.13	10	73.13	53.42	5.77	1.40	8.0
March	5.10	15	78.84	59.17	6.52	3,24	11.1
April	5.01	14	83.22	63.92	6.54	7.53	16.7
May	12.48	18	86.72	70.69	6.93	10.56	19,7
June	11.07	24	87.90	74.56	5.57	13.09	23,0
July	29.28	30	89.23	74.50	5.56	14.99	23.9
August	14.94	26	88.26	74.33	5.38	13.26	22.8
September	15.31	20	88.38	74.44	5.67	10.92	19,8
October	3.31	17	84.06	70.81	4.43	4.29	11.2
November	2.21	5	78.82	60.71	5.38	1.08	4.0
December	0.41	4	73.07	53.93	5.30	0.40	2.5
Total	103.39	191				81.67	167.4

STATEMENT B.

1950	Soil Temperature at 1 ft.				Soil Temperature at 3 ft.				Soil moisture %(top 9")
	Fallow		Grass		Fallow		Grass		
	8 a. m.	2 p. m.	8 a. m.	2 p.m.	8 a. m.	2 p.m.	8 a. m.	2 p. m.	
January	63.41	63 24	63.85	63,57	7.42	67.56	65.88	65.94	15.86
February	66.49	66.22	66.99	66.77	68.37	68.43	67,89	67.93	15.57
March	71.61	71.39	72.30	72.03	71.88	71.94	72.32	72.32	16.00
April	76.07	76.22	76.91	76.90	74 92	75 35	76.11	76.53	15.07
May	80.83	80.68	81,55	81.28	78.08	78.05	80.43	80.46	18.16
June	83.91	84.07	85.07	85 09	80 75	80.80	83.70	83.77	19.33
July	85.03	85.09	85.96	85.97	81.73	81.83	84.96	84.98	20 66
August	85.43	85.11	86.27	85.97	83.30	83 28	85.52	5.42	20.02
September	84.47	84.32	85.14	84 98	82.59	82.66	84.61	84.52	20 55
October	81.86	82.32	882.7	83.05	82.65	82.80	83.18	83 29	17.64
November	74 80	74,80	75.86	75 63	78.22	78.12	77.56	77.40	16.78
December	68.61	68.52	69.01	68.89	72.74	72.82	71.46	71.51	15.55

6. 2. General : Among the outstanding events of the year affecting the tea gardens of N. E. India must be mentioned the Darjeeling disaster and the Great Assam earthquake. During the interval from evening of 10th June to evening of 15th June, the tea areas of Bengal experienced a violent cyclonic storm with unprecedented heavy rain. Damage to property and life was considerable. Communications were severely dislocated. In the hills the damage was very severe indeed, widespread land slides causing heavy damage to life, property and tea areas. On the 15th of August, an earthquake shock of great intensity was felt throughout the whole of Assam. This caused extensive damage to property all over in Assam but North Lakhimpur, Doom Dooma and Dibrugarh circles suffered specially heavily. The actual acreage of tea destroyed by these two disasters is of the order of 1,000 acres.

7. Seismology :

In August last the Meteorological Office, Poona, asked this station for help in connection with their scheme for study of the after-shocks of the Great Assam Earthquake. On our agreeing, a team of experts was sent up from Poona with complete equipment for two Wood-Anderson seismographs, These have been installed in the laboratory and continuous recording was started as from 1.11.50. The equipment belongs to the Goverment of India and this department is responsible only for its daily operation.

N. G. Gokhale'
Physical Chemist.

AGRIC-BOTANY BRANCH.

PLANT PHYSIOLOGY & PROPAGATION.

(1) Nutrienta and growth response.

Field studies of the response to nutrients under various light intensities have continued. An anatomical criterion of the ability of the tea plant to respond (in terms of yield) to changes in light intensity, has been established. Phloem parenchyama cells of the tea leaf contain crystals of calcium oxalate. By using suitable sampling methods a standard count of these crystals can be made from tranverse sections ; this count is designated as the *Phloem Index*. The phloem index has been shown to measure the yield response to light intensity. It is possible that the phloem index will serve to classify tea plants in respect of their requirements of light intensity and nitrogenous manures. The investigation is incomplete in respect of applications but its object has been achieved by the demonstration that the phloem provides an index of considerable importance. Yield alone will not measure the metabolic status of the plant : one measure of this status is the phloem index. Like the cell and the chromosome, the phloem index is an *organic unit* independent of absolute size.

(2) Root growth.

Field observations have been completed. Statistical analysis of the data is incomplete on account of our reduced staff.

AGRONOMICS & BREEDING.

Long term trials at the Borbhetta Field Station have continued. Observations of the effects of prototype plucking machines on plant growth have continued. Nursery propagation of geographical types of the tea plant has commenced : transplantation to the field in connection with this work is due in 1951.

(3) Vegetative propagation.

No practical conclusions have been possible in respect of the use of zinc and mangenese already reported in connection with vegetative propagation (1949). All research on vegetative propagation was placed in abeyance at the end of 1949 on account of our reduced staff.

(4) Quality.

It has been shown that the relative density of the hairy indumentum of the tea leaf is an index of quality. The glabrous condition is prepotent to pubescent. It has been shown that deliberate breeding for hair results in a material improvement of quality. Parents selected only on the basis of a taster's evaluation of quality may give uncertain breeding results unless the quality be associated with a high density of hair. That the tasted quality sometimes may be higher than that measured by the physical factor of hair is considered to be due to environmental quality which is not transmitted by breeding. This research will be extended in 1951 to include the interactions between hair growth and climatic factors in respect of quality, it being established that hair growth is significantly related to climatic factors.

(5) Rim blight and zig-zag.

This work, commenced in 1939 in connection with the strike of cuttings, was in abeyance this year.

(6) Leaf Roll.

Work related to the foregoing has demonstrated for the first time in India the existence of a graft-transmissible tea virus the symptoms of which have been defined as *Leaf Roll*. This has a positive effect on the *strength* of tea and a negative effect on crop yield. Detailed reports have not been possible on account of our reduced staff.

(7) Seed.

It has been found that selection for seed size has a marked selective effect on phenotypes. It has been demonstrated that the initial size of the seed from which a population of plants is raised is a measure of the quality of that population. Either very large or very small seed is associated with quality below maximum. Quality approximates to a parabolic (power) function of seed size. On the other hand, gross size of the plant is a linear function of

seed size (positive correlation). We deduce that *genetic balance* is a factor of importance in the production of quality. This is to be investigated in 1951 (field data already exist).

(8) Plucking.

Modifications of the shape of the plucking surface have proved NOT to be a factor of practical importance in respect of yield. Modification of the height of the plucking horizon has been investigated. The yield of the tea plant follows a characteristic and annually repeated seasonal fluctuation. Two seasons are of major practical importance in the plains of N. E. India—before the first of July, and after this. These seasons may be referred to as "early" and "late". Leading shoots, which arise from dormant buds in response to the removal by pruning of all but the basal $\frac{1}{2}''$—$1''$ of the mature secondary growth of the past 12 months, are repeatedly plucked (decapitated) in their actively elongating distal parts at a fixed horizon, for the production of the raw tea leaf of commerce. Successive pluckings at seven-day intervals remove actively elongating shoots which arise from buds which have not been allowed to remain dormant. For the purposes of argument one may regard some chosen plucking horizon as "normal" (*eg.* 7″-8″). This will give an early and a late yield both of which may be regarded as of normal magnitude. It was known that if the horizon be much lower than normal, then the gross annual yield will be increased at first but will steadily decline from year to year. This trend can be arrested by raising the plucking horizon. There is an optimum horizon of plucking at which the trend of yield with time remains approximately constant. Because early season teas are of the greater commercial value, one has to consider the possibilities of increasing the early season yield by plucking low and thereafter raising the horizon in the late season with the object of avoiding or of minimising the bad effect of an early low horizon. To some extent this is possible, but various complications are found. There is an inevitable mechanical loss in the late season, due in part to the period of non-plucking during which time the new higher horizon is being attained. A fiald trial designed by Mr. H. R. Cooper and continued now for 16 years, shows that with an annually repeated low plucking in the early season, the high yield for that season gradually returns to "normal"; at the same time, the loss in yield resulting from the higher plucking in the late season, tends to become less; the late season yield tends to increase. For either season, the long term trend is to revert to normal. These experiments show that it is not possible, by alteration of the plucking horizon, permanently to maintain a yield which is above normal for a particular season. Statistical studies will be continued to include interactions with manuring and the affect of medium pruning (removal of part of the permanent frame) after prolonged repetition of the plucking treatment.

(9) Pruning.

Observations, parallel with the foregoing, have been made of the effect of twelve dates of pruning (annually repeated) the horizon of the pruning being constant and the horizon of subsequent plucking being constant and optimum. The shoots which will be subjected to plucking arise from dormnnt buds on mature (secondary) wood. One time of pruning (November) may be regarded as "Normal". Any other time results in a gross annual loss relative to normal, but can increase yield above that which is normal for some season, this season depending upon the time of pruning. It is possible to raise the yield during any limited season, by pruning at the appropriate time ; and the annual repetition of such pruning results in the maintenance of super-normal yield (during a particular season) for the period of years during which low plucking ceased to have any effect (*vide* para. 8 foregoing). It is of interest to note the effects of the practical operation of skiffing. If, after early season low plucking, the shoots are allowed to grow well above the normal level (by omitting to pluck) and are then cut across at the normal level and thereafter are plucked, then this operation is designated as "skiffing". It involves cutting semi-mature wood ; regeneration being from buds not long dormant and situated on parts of the stem where secondary growth is not far advanced. The skiffed growth is thrown away and is lost to yield totals. The mechanics of the operation inevitably reduce late yield very considerably. But the rate at which the early super normal yield diminishes from year to year, is greatly reduced ; in this respect the effect of skiffing approaches that of pruning ; and as with other treatments, the late season loss diminishes,

Whilst the assimilation, conditioned by the number of leaves which are allowed to remain upon the bush by manipulation of the plucking horizon, undoubtedly is of importance, more factors than this are involved. It will be noted that the operation of plucking is that known to horticulturists as "stopping". Although low plucking (followed by higher plucking in the late season) results in a decline in early season yield, it does not have this effect on late season yield. The most fundamental factor seems to be the phenomenon that the innate (genetically conditioned) periods of yield, (of a given nature of initial shoot which arises at a given season from a dormant bud) are keyed in relation to the solar seasons ; and it is not possible to maintain the plant permanently out of this relation. Photoperiodic relations appear to be involved. Self evidently, more detailed physiological considerations are abstruse, but the phenomenon in itself is of importance.

The foregoing account (paras. 8, 9) deals with the technical nature of the investigation. From this it would be highly unwise to draw any practical conclusions ; these require detailed treatment of the relative losses and gains at different seasons ; and such publications have not been possible since the Agric-Botanical Staff was reduced in 1947.

W. Wight.
Plant Physiologist.

APPENDIX TO AGRIC-BOTANY ANNUAL REPORT 1951.

STAFF.

Mr. D. N. Barua, B. Sc. left in August for post-graduate training at Cambridge.

TOURING.

The Agronomist visited 11 gardens in the Tezpur circle, 19 gardens in the Sibsagar district and 5 gardens in the Panitola Circle. The Plant Physiologist visited one seed bari in the Sibsagar district.

LECTURE COURSES.

During the General lecture course the Agronomist delivered 9 and the Plant Physiologist 6 lectures. The Plant Physiologist and the Agronomist jointly ran two courses on Vegetative Propegation—

Course VII — 22 May to 26 May, 1950.
„ VIII — 29 May to 2 June, 1950.

ADVISORY.

The Agronomist wrote 926 letters and the Plant Physiolosist 368 letters during the year.

PLANT PATHOLOGY DEPARTMENT

The plant Pathologist, Mr. E. Hainsworth was on leave during the early part of the year, and the Entomologist Dr. G. M. Das officiated as Plant Pathologist until Mr. Hainsworth's return in July. During the year extensive renovations have been carried out in the department, bringing a marked improvement in working conditions in the laboratory, and especially welcome are the improvments in lighting and drainage.

The volume of work passing through the department has continued to increase : during the year 766 advisory memoranda were written, 454 specimens of pests and diseased material from Tea Estates were examined, and 20 advisory visits were made to Estates. It become necessary to form a small advisory unit in the department, in charge of Mr. K. C. Sharmah, the Senior Mycological Assistant, who now handles all routine advisory work which comes to the department.

Entomology

Residual toxicity of acaricides

The residual toxicity of acaricides appears to play a very important part in coutrolling Red spider on tea, particularly during the flushing season. The higher the residual action, the more will be its effectiveness, irrespective of direct action whether it is high or low. For instance, soaps or oil emulsions such as, 'Whiz' give 100% kill of all Red spider stages in laboratory tests, but they have no residual action, and those mites escape which are not actually hit by the spray fluid at the time of application. In the field it is difficult to cover all the leaves of every bush with spray fluid. As a result, the unaffected Red spiders form new colonies and in a short time a second outbreak develops. Even a second round of spraying with such acaricides does not eradicate them completely. On the other hand, although wettable sulphur and other sulphur preparations do not affect the quiescents and eggs of Red spider, when applied they have considerable residual action which destroys many of the adults as they emerge later.

In a spraying trial in which tea bushes were sprayed with 'Whiz', 'Spersul' and lime sulphur, only the perimeters of the bushes were sprayed, the centre branches being left unsprayed. The Red spiders died within two or three days on the centres of bushes sprayed with lime sulphur, and later those in the centres of the Spersul-treated bushes died. Those in the centres of bushes sprayed with 'Whiz' appeared to be unaffected.

There is also an important difference between these two types of spray fluid in their effect on the predators of the Red spider. Sulphur based sprays are less lethal to some stages of Coccinellids than are oil emulsions and soaps (See Table I).

The possibility of combining two acaridides, one which affects all the stages of the mite and the other with some residual action, has our attention.

Effect on foliage

None of the recognised acaricides which we have tested cause foliage injury.

Probable Effect of Rain on the Efficacy of the Acaricides

To find out the probable effect of rain on the efficacy of acaricides trials were carried out in the laboratory by washing off the acaricides at 24, 48, and 72 hours after treatments, with plain water by means of an Eclipse Pneumatic Sprayer, at a pressure of 75—100lbs., from a distance of 3'—4' above for 10 minutes. The results are summrrised as follows :

Almost all the active forms and quiescents which have been either killed or slightly affected are washed away at 24 hours or at subsequent washing. The efficacy of sulphur and lime sulphur depends considerably on their residual toxicity which is slightly reduced by 10 minutes washing.

Whiz penetrate the outer surface of all Red spider stages including the quiescents and eggs, and a maximum period of 24 hours is normally required to have full effect on all stages. Subsequent rains do not seem to reduce its effect.

Clensel which is a liquid soap, does not penetrate into the tissues of Red spider stages, instead it forms a covering which on being dried up kills the active forms and prevents the moulting of quiescents and hatching of the eggs. It is easily washed off by rains and Red spider stages which have not already been affected, particularly the eggs which are due to hatch afterwards escape destruction.

Red spider control trials

A field trial with selected acaricides was conducted for us by the manager of Burnie Braes Tea Estate.

Each plot contained 400 bushes, but the area was not uniform and the treatments were unreplicated.

The following are the plucking figures for the treatments :—

Treatments	Total green leaf in lbs,
Spersul 1lb. + Sandovit 5 ozs. + Water 20 gallons (single spray) ...	700
Lime sulphur 33° Beaume, 1 to 31 parts of water (double spray) ...	800
Check	488
Whiz, 1 to 80 parts of water (single spray)	604
Limesulphur 33° Beaume, 1 to 31 parts of Water (Single spray) ...	688

The order of yield in this trial accords well with results obtained in previous trials.

Control of tea chest borers

A small trial was conducted with deodorised DDT against borers attacking tea chests. The shooks were sprayed lightly on both sides. The treated shooks were then placed alternately with the infested ones, one above the other. Periodical observations, continued for nine months after treatment, did not reveal any attack to treated shooks, whereas the untreated infested shooks were badly damaged.

A complementary trial carried out by the Advisory Officer, Assam Valley, indicated that tea packed in boxes made of treated plywood became tainted.

Membracid.

In a small field trial, DDT at 0.1% concentration gave 100% control of the membracids attacking young shade trees viz, *Albizzia stipulata* and *Albizzia odoratissima*, but it had no effect on the eggs. Subsequently hatched insects died soon after hatching on the sprayed bushes.

The duration of residual action on the adults could not be estimated as they could not be kept alive either on untreated or treated branches in confinement. The details of these results can be found in the third quarterly report for 1950.

Flea beetle.

A flea bettle (*Longitarsus rangoonensis*) is known to cause appreciable damage to *Crotalaria*, particularly in the early stage of growth. A replicated experiment with DDT and Gammexane was carried out for the control of this pest at Borbhetta. There were 7 treatments with 4 replications and for each treatment, a row of about 50 ft. long, of *Crotalaria* plants, having an average height of 2 ft., was taken.

Observations were made at 7 places at random in a row each consisting of 6-10 plants.

Treatments	No. of flea beetles present after spraying		
	3rd day	8th day	16th day
1. Gammexane D.025 (dust) ...	0	0	7
2. Gammexane P520, 1 lb. to 20 gals. of water.	0	0	10
3. „ 1 lb. to 30 gals. of water.	7	8	17
4. „ 1 lb. to 40 gals. of water.	18	20	25
5. „ 1 lb. to 50 gals. of water.	53	60	58
6. DDT 50% W. P. 1 lb. to 50 gals. of water.	2	5	15
7. Check	99	101	94

Bruchid

Bruchids very often cause a considerable damage to seeds of *Tephrosia candida* (Boga medeloa) and occasionally of Sau. The damage is not easily detectable at the time of collection of seeds, but shortly after or in storage, the adult bruchids begin to emerge by boring a hole. The adults have never been found to lay eggs on or inside the collected mature seed pod or on dried seed. Seeds which are collected after maturing are already infested. Search in the field for adults in oviposition has gone on for some years, and this year adult Bruchids were found on *Tephrosia*, when the pods were forming. The eggs are laid on young pods and remain attached to the outer surface between the hairs. The egg is tiny, more or less pear shaped. The grub on hatching bores into the pod, and wanders about until it encounters a seed, and enters it by making a small hole.

In the majority of cases, only one grub is found inside a seed but occasionally one seed contains two or more grubs. When full-fed the grub pupates inside the seed and emerges later as an adult.

Examination of freshly collected mature pods shows that the pest is found in seeds either in the grub stage or in pupal stage. Adults emerge in large numbers at the time of threshing the dried seed pods. At this time many seeds have exit holes which indicate that the beetles have already emerged.

It is difficult to detect the infested seeds which have either grubs or pupae inside, without examining them carefully with the aid of a hand lens.

In the absence of detailed information, the present method of dealing with the pest consists of the treatment of seed with DDT or Gammexane prior to storage. This method destroys the bruchids when they emerge and obviously reduces the population which might be the source of infestation in the following year. Whether this treatment has any effect on the grubs and pupae in the infested seeds is a point not yet investigated.

The question of controlling the pest in the field will arise only if this becomes a serious problem. It appears that the residual effect of DDT sprayed for the control of Apion slightly reduces the intensity of bruchids.

TABLE. 1.

EFFECT OF ACARICIDES ON IMMATURE STAGES OF COCCINELID PREDATORS OF RED SPIDER

	Effect on grubs			Effect on Pupae			Effect on eggs			Residual effect on grubs		
	Total No. of grubs examined	Number killed	% killed	Total No. of pupae examined	Number killed	% killed	Total No. of eggs examined	Number killed	% killed	Total No. of grubs examined	Number killed	% killed
Whiz 1 : 85	75	71	94.7	10	10	100	10	10	100	25	4	16
Clensel 1 : 25	75	75	100	10	10	100	10	9	90	25	2	8
Spersul 1 : 150	75	42	56	10	0	0	10	0	0	25	8	32
Spersul & Sandovit (1 : 1/5 : 150)	75	52	68	10	1	10	10	4	40	25	10	40
Thiovit 1 : 100	75	63	84	10	3	30	10	5	50	25	5	20
Lime sulphur (Fernasul) 1 : 40	75	67	89.3	10	2	20	10	4	40	25	7	28

BACTERIOLOGY

Weekly bacteriological tests were carried out on the Tocklai water supply throughout the year. The water sterilization plant continued to function satisfactorily as shewn in Table II.

TABLE II

Mean Numbers of Lactose fermenting bacteria per cc of water

Month	Untreated	Treated
January	9	1
February	8	0
March	9	0
April	8	1
May	8	1
June	9	1
July 10 & 11	110	4
Rest of July	7	0
August	6	1
September	6	1
October	8	0
November	7	0
December	4	0

The disproportionately high count of lactose fermenting bacteria on July 10th and 11th was observed after heavy rains had resulted in an overflow of water from contaminated tanks into one of the drinking water tanks. To prevent a recurrence of this a new flood drain has been constructed. The rapid natural fall of the numbers of lactose fermenting bacteria in the tank to the normal level soon after contamination took place is noteworthy.

MYCOLOGY

Red Rust

Experiments in Red Rust control are continuing at Kotalgoorie Tea Estate. Further experiments in spraying for Red Rust control on hedge-planted tea, commenced in April, will mature in May 1951.

Yields continue to be taken on the experimental plots of the Red Rust control trials begun in 1949. The experiments are designed to determine the effect of Perenox, lime-sulphur, pruning versus skiffing, and potash manuring on the yield of young tea affected by Red Rust. No significant results have been obtained so far.

Mineral Nutrition

A start has been made in the adaptation of the methods of Roach and Roberts (Imperial Agricultural Bureaux Technical Communication No. 16 - Plant Injection for diagnostic and curative purposes - W. A. Roach and W. O. Roberts, Esst Malling Research Station 1945) to study the mineral nutrition of the tea bush. Injection is performed by placing the cut mid-rib of a leaf into a small tube containing a pure solution of a salt of the element to be investigated, so that the solution is rapidly absorbed into the plant. This work promises to be of interest, as it is possible to study the effect of any number of elements on a single bush, because the observable effects appear only on the injected shoot.

The injections can be easily and rapidly carried out and it is hoped to evolve a technique including this method and the use of indicator crops for the diagnosis of possible mineral deficiencies on the so-called 'backward' areas. The following standard elements are used in the tests :—

Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Iron. Manganese, Zinc, Copper, Nickel, Boron.

Spectrographic analysis

Arrangements have been concluded with another Research station in India for the spectrographic analysis of tea leaf samples. Over 600 small samples of made tea have been drawn from Estates throughout N. E. India, and also from South India and Java, and these samples are now being analysed.

Effect of spraying on quality

This is a joint investigation with the Biochemical Branch. Leaf sprayed with various insecticides and fungicides was manufactured and tasted. The results appear in the Biochemical Branch section of this annual report.

Susceptibility of Agrotypes of tea to Blister Blight

Artificial inoculation of *Assamica*, *Cambodiensis* and *Sinensis* shoots with spores of Blister blight was carried out during the year. Satisfactory techniques for this work have not yet been perfected and the results were inconclusive.

Systemic Fungicides and Blister Blight

Work has commenced in Darjeeling on the control of Blister blight with systemic fungicides. The principle of such control techniques is that the tea bush, being induced to absorb a chemical, develops a temporary resistance to a specific disease. Such work is parallel with work on systemic insecticides and acaricides already reported in last year's Annual Report.

Only one systemic fungicide, 8-hydroxyquinoline has so far been tested, and has been found to be ineffective. It was useful in that a screening technique has been developed using 8-K-hydroxyquinoline for the rapid

assessment of systemic fungicides in future. The department approached Imperial Chemical Industries with a list of chemicals which might have systemic fungicidal properties, and this firm has kindly consented to synthesise small amounts of these compounds for our use.

The year closed with Blister blight present and spreading in almost every tea district, and the urgent need for new developments in Blister blight control is very apparent.

Soil Injection Experiments and Eelworm Control

Further injection trials were carried out in collaboration with the Scientific Officer, Jorehaut Tea Company at Hattigarh Tea Estate. DD Mixture and Dowfume, two soil fumigants, were tested. It was apparent from visual examination of the plots that the treated ground contained healthier and more vigorous plants than the untreated ground. It was not possible, however, to resolve this difference into measurable terms with statistical significance. The eelworm population on the area was low and extremely variable—even on one of the check plots only 9 out of 130 plants were affected.

Disease of Tea Flowers

Work on the control of this disease, previously referred to as '*Sclerotinia*' and now confirmed to be caused by a fungus which is a member of the *Sclerotiniaceae* family, is now concluded, although laboratory investigations of the fungus continue. A spray fluid consisting of 1% Burgundy mixture and 0.1% Zinc sulphate has been found to give increased seed crops when applied to badly affected seed trees at the time of flowering. On high-yielding seed trees which are not badly affected by the disease, this spraying fluid causes a reduction in crop, and this fact must be carefully considered before a decision to spray a seed garden is reached. (See our 4th Quarterly Report for 1950 for a more detailed note).

Virus Diseases of Tea

Observations and records continue to be taken on a set of symptoms, some of which may be associated with virus diseases.

E. Hainsworth
Plant Pathologist.

ADVISORY OFFICER - DARJEELING & TERAI

1. General.

The year 1950 was a testing year for the Darjeeling District.

The season opened with droughty conditions which not only affected crop in the early part but was reflected in the degree of incidence of Matatranychus bioculatus, (Red spider).

In the hill Gardens, on top of Red spider came Thrip which added to the troubles and further retarded growth.

Towards the middle of June however a disaster of the greatest magnitude occurred when phenomenally heavy rains over a period of 48 hours caused a series of landslides in the Tista Valley area, and the more Northerly portions of the Darjeeling and Kurseong subdivisions. Communications were completely disrupted and the Industry was suddenly faced with the task of arranging for supplies of food and essential stores, and the transport of its tea in the opposite direction.

How these problem were tackled, and how the Industry not only helped itself but Government and the public generally is now past history, but the numerous slips where tea previously existed and are still unconsolidated remain a threat to both main line and internal communications and have still to be dealt with.

At the end of the year through traffic by both rail and road was not possible from Darjeeling, but plans were in hand to restore communications by repairs of the Sonada breach. In the Tista Valley work was also in progress to repair the Lukbir breach for motor traffic to Tista Bridge, but it is understood the railroad will not be reconstructed.

Presumably as the result of the excessive rainfall, the saturation of soil both in the hills and the plains which resulted, had its repercussions on growth and up to the third week of August crop production was well behind. Towards the end of August at the lower elevations conditions improved and in general the position was retrieved considerably. In the Hills however recovery came too near to the end of the season and crops were generally down by 0.5 to 1.0 mds. per acre on the previous year's crops.

In the Terai, forcing climatic conditions led to a good back-end, yields were generally above average.

The rains ended early, and the normal "Christmas" rains failed completely.

2. Field Experiments.

(a) Data for Margaret's Hope manuring experiments were under examination at Tocklai at the end of the year.

Yields for the Dooteriah and Kalej Valley manuring experiments have also been forwarded to Tocklai for analysis.

Initial yields figures for the Tumsong and Mim Pruning experiments were collected during the 1950 season.

(b) **Observation Plots at Dilaram T. E.**

Mention was made in the Annual Report for 1949 of the incidence of Aglaospora aculeata in a degree of considerable severity in this Estate and it was stated that after pruning many bushes failed to recover.

Aglaospora as far as is known from existing records is a weak parasite only causing death in cases where a bush is highly debilitated. A block of tea pruned in 1948-49 which exhibited the symptoms of attack was rested by light plucking during the following season and it was felt on observation that in general a marked degree of recovery had occurred. In the light of this, and in view of the fact that weak bushes were unable to withstand the normal prune, observation plots were laid out in an area pruned under normal Estate practice in 1949-50, and in one due for pruning in 1950-51.

In the former bushes were classified as "weak" or "moribund". Inspection at the end of the season disclosed that in general no appreciable recovery had occurred in any of the bushes marked down as moribund, or weak. Many bushes appeared to be beyond recovery.

In the latter plot classification was under "Vigorous", "Weak" or "Moribund" and a number of each class was pruned under normal Estate practice, a similar number were "Rim-lung" pruned, that is, branches in the outer periphery were left unpruned, those within being pruned under normal Estate practice. The plots will be inspected at the end of the 1951 season and an estimate made as to whether the retention of breathers has reduced the heavy mortality which now occurs after normal pruning. The plots should also indicate whether apparently healthy bushes are affected by normal pruning.

It is feared however that the origin of the present dangerous condition may be due to other more obscure reasons.

The Plant Pathologist who visited the area in September 21st. 1950 suggested the possibility that the primary cause might be due to a virus disease. Information on this subject is awaited from a worker who had investigated virus disease of tea in Ceylon.

(c) **Miscellaneous.**

(i) **Vegetative propogation.**

As far as experiments in the techniquee of raising internode cuttings at this Headquarters is concerned, trials initiated last year were repeated during the year under report and confirm the findings of last year.

A great deal of very valuable experience and information has been gained in connection with the whole subject of selection and raising of cuttings in Ambootia T. E. and the writer hereby gratefully acknowledges the kindness of

the Superintendent, The Darjeeling Co. Ltd., and the Manager, Ambootia T. E. for affording him facilities to visit the areas where work is in progress.

In the light of the progress made in this Company there can be no doubt that the method is an eminently practicable one for raising growing stock of a high quality, and although complications have arisen in respect of selection of mother bushes in relation to the establishment and maintenance of "Darjeeling" flavour, and the final decision as to how this is to be attained is still to be made, there can be no doubt that the introduction, under uprooting and replanting and infilling programmes, of material selected for desirable qualities cannot but increase the potential value of the growing stock generally.

Considerable interest is now being evinced by other groups in the District and it is envisaged that in the not too distant future, the system will replace to a great extent the employment of seed collected, often indiscriminately, from tea under plucking, with all the inherent dangers this implies of raising a mixed stock, a great proportion of which may have undesirable characters.

In the Terai, interest in the subject has also increased considerably.

(ii) Panighatta T. E. Vegetative Propogation area.

During the year a number of rooted cuttings of Tocklai releases as follows were flown to Bagdogra and planted out in the plot to form Nucleus clones :—

(a) 19-29-13 50
(b) 1- 7- 1 50
(c) 20-23- 1 50

Growth under the particular conditions of this locality will be studied. In due course the Nucleus clones will be used as a multiplication area for distribution of cuttings to the Terai, the Darjeeling District, and possibly also the Dooars thus obviating existing difficulties of transport from Tocklai and all the expense this entails.

Arrangements are being made at Tocklai to carry out parallel trials of clones under test but not yet released.

The writer acknowledges with thanks the facilities afforded, and the interest taken by the Manager, The New Terai Association Ltd. in this connection.

(iii) Thrip Control.

Preliminary laboratory trials were conducted at this Headquarters on the effect of D. D. T. on Thrip. Thrips at all stages of development were rapidly destroyed by D. D. T. in contact with them.

Inspection of infested shoots sprayed with a ·025 % D. D. T. in water mixture, disclosed that where the spray was able to penetrate to the axils of leaves, Thrip present were rapidly destroyed, and no fresh infection occurred during the 5 days of the trial, though unsprayed infected shoots were placed in the same container.

As further leaves opened however Thrip were observed to be active.

This is as might be expected as, with growth, leaves hitherto enclosed in the bud emerge unprotected by the original spray. Examination of bushes in the field will show that adult Thrip are active at the axils of partly opened leaves, and it is likely that spraying will effect a reasonable kill of the more active stages. While further detailed investigation is required to study movement of Thrip, the small scale trials conducted with D. D. T. gave, it was felt, sufficient evidence to suggest a possible method of control.

Thrip is most damaging to pruned tea, which is delayed in attaining the desired tipping measure by the stunting of growth which results from the insect sucking sap from the tissue. It was felt that if the extent of damage could be reduced by causing a reduction in the degree of infestation, an increase would occur in the rate of growth and as a corollary thereto the tipping measure would be attained quicker. Thereafter normal plucking operations would automatically result in a considerable depopulation, particularly of the relatively inactive instars and possibly eggs and it could be expected that under normal growing conditions subsequent regular plucking would hold the pest in check.

An Estate in Darjeeling undertook a simple test on these lines, and reports received indicated that spraying with D. D. T, was effective, pruned tea which was sprayed being almost immediately after pruning stimulated to very active growth, outstripping unsprayed tea adjoining it.

While further detailed trials are necessary to establish optimum concentration of D. D. T. sprays, period at which it should be applied, and number of applications, it is felt that there is sufficient evidence to recommend tentatively the application of the above measures should a severe incidence of Thrip occur in the early part of the season.

(vi) Treatment of Tephrosia candida & Crotalaria anagyroides in mature tea.

Reference was made in the Annual Report for 1949, to a coppicing treatment of Tephrosia candida under trial in a certain Estate in Darjeeling. A further coppicing was carried out in the cold weather of 1950, and stems thus treated threw out vigorous regrowth during the season. This is the second year in which coppicing was done.

Crotalaria sown in April 1949 in the Headquarters compound was coppiced in February 1950. A complete regrowth resulted during the growing season. It would appear therefore that this species can also be similarly treated by this method.

(v) Local alternative green crops—

(a) Desmodium gyroides

Desmodium gyroides referred to in a Quarterly report as under trial for employment as an alternative green crop, (and which last year showed

great promise), has exhibited this year at this Headquarters very severe Eel worm attack, and as such cannot be recommended for growing in tea where ground may be required for the formation of nursery beds.

It produces a great quantity of litter if treated under the coppicing system referred to above, and as such might be considered for use outside tea areas e. g. aforestation areas, for the production of green manure for application to tea or the production of compost.

(b) **Indigofera endecaphylla.**

Cuttings from a small bed of the above species (hitherto termed Indigofera anabaptista) were set into a considerable area of grass and weed covered ground at this Headquarters, and struck with great ease. This species forms a very appreciable proportion of the weed growth on the ground, and while it does not suppress other growth, must have considerably increased the nitrogen content of the area. The species is worthy of consideration for introduction into newly planted areas.

(c) **Priotropis cytisoides.**

Seed of this species, obtained from Singell T. E. was sown in a terrace at this Headquarters in March, 1949 and was some 4′ 6″ high at the end of the season. By the end of the year it was still completely green whereas Crotalaria in an adjoining area had lost a considerable amount of its leaf. *Priotropis* is known to respond to the coppicing system referred to above, and in view of the fact that in drier localities both *Tephrosia candida* and *Crotalaria* lose much of their leaf by the end of January it is worthy of consideration whether mixed sowings of *Priotropis* and the latter may not offer a solution to the provision of some shade during the hot weather where this is desirable.

It may be noted that the growth forms of the particular plants raised here are excellent and do not exhibit the low branching habit of those seen at Tocklai and in the Dooars.

3. Pathology.

(i) **Exobasidium vexans**—(Blister Blight).

The experience of the previous year was fortunately not repeated this spring, for Blister Blight was almost completely absent in the spring in the Hills. This is presumably attributable to the droughty conditions which prevailed at the start of the growing season.

This fact however did not reduce the severity of attack during the rains, when it appeared in a high degree of incidence in the middle of July. It continued unabated as usual right through the rains and the early autumn.

In the Terai it appeared as usual in the foot hills in September and continued well on into the cold weather.

A small short term experiment designed to study the effect of times of pruning on production of early crops in the following spring yielded some

valuable information on times of pruning in respect of damage from Autumn Blister.

Plots were pruned in September, October, November and December in area at an elevation of some 2500'.

September pruning resulted in regrowth during the current growing season. This coincided with Blister Blight at a high degree of incidence and the majority of the shoots were attacked by both leaf and stem Blister. October pruned plots had only just started regrowth by the end of the growing season and shoots were only slightly affected. November and December pruned plots formed no regrowth during the current season.

Any advantage that was expected from the early prune was thus completely nullified by Blister.

(ii) **Aglaospora sp.** (Thorny stem blight).

Reference has already been made above to this fungus.

In another Estate in the District a block of tea on a somewhat dry ridge exhibited a number of bushes in a sickly state with plentiful evidence of the disease. The treatment suggested here to prune and remove affected branches coincided with the normal cut back programme and it has thus been possible to clean out to healthy wood. It will be of interest to watch whether the treatment accorded halts the progress of the disease.

(iii) **Thread Blight.**

A number of Estates, particularly those at the lower elevations, possess areas where Thread Blight is comparatively serious. Worst affected Blocks are associated with hot humid conditions and are usually found in localities where there is jungle in the vicinity.

Winter spraying with a Copper fungicide has not proved entirely effective. It is felt that this may possibly be due to the fact that in the dry weather the fungus mycelia are in an inactive state, and by the time they become active with the advent of wet weather any residual effect of the copper fungicide has disappeared.

Under such circumstances application of the fungicide may prove more efficacious once the rains have set in and growth is active. The habit of the particular blight however makes it impossible to ensure that complete destruction of all mycelial strands can be effected, and fresh infection may occur from those which have escaped the fungicide. This would appear to indicate that fungicidal treatment will have to carried on for a considerable period where the fungus is widespread. It is suggested that in areas at low elevations where the degree of infestation is high, it might be of value to treat blocks on an annual prune for a number of years in order that spraying operations will not be impeded by a heavy leaf table, as occurs in the unpruned years of longer cycles.

(iv) Corticium invisum (Black Rot)

Black rot was identified in two gardens in the Hills during the year.

(v) Other fungus diseases.

During the year samples of diseased tea bushes were received from various Estates. *Ustulina zonata*, (Charcoal stump rot) proved to be the most frequent identification made. *Fomes lamaoensis* (Brown root rot) also appeared fairly frequently.

Rosellinia arcuata (Black root rot) was identified in specimens from the Tista Valley.

(vi) Meta tetranchyus bioculatus Red Spider & Thrip.

Red spider was very active in both the Terai and in the Darjeeling area, and was without doubt accentuated by the droughty conditions which prevailed prior to the growing season.

Where Thrip supervened on Red spider recovery of attacked bushes was very slow.

A dusting experiment with a mixture of 5% DDT and 50% Sulphur was carried out in an Estate in the Darjeeling area. The trial was somewhat vitiated immediately after application of the dust by a very heavy downfall of rain, and no definite results could be obtained. Apart from this however the apparatus used in the trial namely a hand operated "Blower" and a Rootas Duster did not prove entirely satisfactory. The former was tiring to operate and much time was wasted in constant refilling of the very small container. Efficiency of the latter gradually deteriorated as the dust in the container was used up.

Dusting with a mixture of this nature however might prove an answer for the Darjeeling District with all its difficulties of carriage of water, were a power machine available which would suit the difficult terrain in which it would be required to operate.

(vii) Helopeltis theivora (Tea mosquito bug)

No reports of particularly virulent attacks were received during the year, though *Helopeltis* was as usual present in most areas.

There is no doubt that application of recommended control measures immediately the pest is observed prevents an attack in epidemic form developing.

There is still a tendency however to treat Helopeltis at the end of the season as not worth worrying about. It is for consideration whether failure to deal with a comparatively heavy attack at this period is not conducive to the danger of an early attack in the following growing season.

(viii) Root boring Longicornae.

During the year evidence accumulated that damage to root systems by "Longhorn" Beetle larvae was widespread. The presence of frass at the base of the bush is symptomatic of attack. Where the bush is a single stemmed

one, or consists of a few stout stems only, the holes from which this frass are ejected during the boring operations of the grub can often be found, and injections of an insecticide such as DDT or Gammexane with water can be expected to kill those larvae which have not gone down too deeply. It is not easy to find the ejection hole in the case of multiple stemmed hybrid bushes and little action can be taken in this type of bush once the larva has started tunnelling down a root.

Bushes from a number of localities were examined, and in every case it is the larger deep roots that are attacked thus making the bush less resistant to droughty conditions.

Hand collection of the adult beetles would it is felt help considerably in controlling this pests.

(ix) Miscellaneous insect pests.

At Singell Estate a number of bushes in a small area was attacked by Lymantrid caterpillars which were causing considerable defoliation. Spraying with DDT ·025% water mixturs effectively dealt with this pest. A similar attack was reported from another Estate last year.

Damage to shoots at Phuguri T. E. was attributed to a heavy attack by Jassids (Leaf Hoppers).

Peal's Beetle (Diapromorpha melanopus Lacord) a small orange coloured beetle with a black head which appears in swarms was responsible for an appreciable amount of damage to tender shoots of vegetative cuttings at Ambootia T. E. The beetle chews the stems of tender shoots which are partially severed and causes them to bend over and eventually die. The beetles normally appear in the late afternoon and seem to come in from jungle that may be in the vicinity of the area attacked.

Limited control might be effected by spraying with DDT or Gammexane, when the beetles are on the plants. This will not it is feared prevent damage from this particular brood, but may reduce excessive multiplication of future ones.

(x) Eelworms (Heterodera maroni)

The presence of heavy eelworm infection of Desmodium gyroides growing in this Headquarters compound led to a critical examination of seedlings being raised in several nursery beds in the compound. Eelworms were found on a number of seedlings and no doubt accounts for the variable growth of individuals. It should be remembered however that the area in which plants are being raised is "dirty" having been used for many years for raising vegetable crops prior to occupancy by this Branch. A considerable proportion of the ground now being used was also recovered from weed covered land, and heavy eelworm infection is not therefore abnormal.

Experience here however does raise the suspicion that generally in the Darjeeling District, Eelworm infection should be considered as a possible cause

of poor nurseries where they occur. The fact that seedlings in the middle and upper elevation Estates have to be held for two years before planting out in many cases accentuates the extent to which damage might occur. The selection of areas and preparation of nurseries deserves careful attention therefore (See Serial No. 67 of the Tea Encyclopaedia filed under J. 3.)

Similar considerations apply to areas selected for vegetative reproduction.

4. Staff.

During the year one post of Chowkidar was abolished and combined with that of Mali. Otherwise there have been no Staff changes.

5. Touring.

(a) **Advisory Officer.**—A number of Estates were visited during the year. The landslides of June interefered considerably with touring, not only on account of disruption of communications but also owing to the preoccupation of most Managers with matters arising out of the disaster.

Visits were also made to the Dooars largely for liason purposes, though individual Estates were visited for examination and discussion of specific or general problems.

In September the writer represented Tocklai at the U. P. A. S. I. conference at Coonoor which was followed by a most interesting and instructive tour in the High Range area of Travancore.

A visit was made to Tocklai during the period of the General Courses.

(b) **Tocklai Officers.**—Dr. Roberts, Biochemist, Tocklai visited the Darjeeling area on two occasions and conducted experiments in manufacture. Mr. D. J. Wood, Assistant Biochemist also visited Darjeeling in pursuance of these experiments.

6. Lectures.

During May a short course of lectures was held in Darjeeling at which both Darjeeliug & Terai members were represented. The lectures included the elements of Botany, Mycology and Entomology as well as subjects connected with the culture and manufacture of tea generally.

A general talk on tea generally was given in the Dooars for Dalgaon and Binnaguri District members, and a talk of Vcgetative propogation was given in Chalsa.

R. I. Macalpine
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